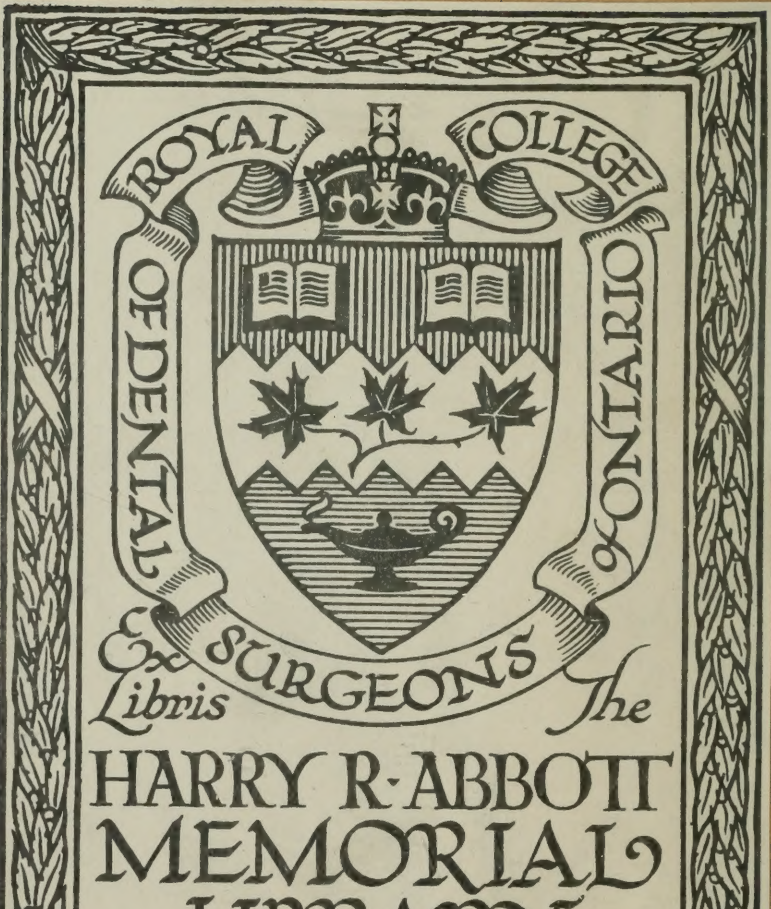
GOLDEN RULES
OF
DENTAL MECHANICS

HAROLD OSBORN

SECOND EDITION



ROYAL COLLEGE OF DENTAL SURGEONS of ONTARIO

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GOLDEN RULES
OF
DENTAL MECHANICS

(NOTES & FORMULÆ)

BY

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SECOND EDITION.

BRISTOL: JOHN WRIGHT AND SONS LTD.
LONDON: SIMPKIN, MARSHALL, HAMILTON, KENT AND CO. LTD.

[1923?]

PREFACE TO 2ND EDITION.

The reception accorded to the first edition has been most gratifying and has been such as to necessitate a reprint within so short a time. In this, the second edition, the notes have been revised, and new items added. The author trusts that it may be received as favourably as its predecessor.

Harold [illegible]

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PREFACE TO 1ST EDITION.

THE aim of the author in the following pages has been to set out and record, in a convenient form, some of the most useful hints, notes, and data derived from the practical experience of the past twenty-two years, many of which have been devoted to technical, experimental, and research work.

No endeavour has been made to compile a complete handbook; text-books already exist in which all the various processes are fully dealt with, and no claim for originality is made for many of the hints contained herein.

In a small work of this description the information is necessarily incomplete, but from a practical point of view it is hoped that the information given may prove useful and of interest.

Harold Dobson

"ELLESMERE",
CASTLEBAR PARK,
EALING, LONDON, W. 5.

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GOLDEN RULES
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Part I.

PLASTER WORK.

Plaster-of-Paris (anhydrous calcium sulphate) is made from gypsum by careful dehydration in a kiln (so that $CaSO_4\ 2H_2O$ becomes approximately $2CaSO_4\ H_2O$). When subsequently mixed with water it has the property of 'setting' (with the re-formation of $CaSO_4\ 2H_2O$).

To obtain the greatest strength in a plaster cast, mix in the proportion of :—

Plaster-of-Paris	8 oz.
Water	4½ oz.

The breaking strength of this mix is about 600 lb. to the square inch.

Remember that plaster expands on setting.

If plaster sets too quickly when new, spread it out as thinly as possible on a newspaper for an hour or two.

When it is old and sets too slowly, use less water, but discard it if possible.

When mixing, sift the plaster with a large tin dredger into the water until it is saturated; do not tip it in, in bulk quantities. Stir thoroughly and smoothly.

When an extra hard model is desired, use plaster-of-Paris previously mixed with the best Portland cement in the proportion of 1 part of cement to 20 parts of plaster.

Special plasters are now prepared which set extremely hard, and do not warp like ordinary plaster. They require several hours to set.

When mixing plaster-of-Paris for impressions, the addition of a few drops of liquid cochineal, besides making it more pleasing to the eye of the patient, acts as a dividing mark after the impression has been run ; a few crystals of permanganate of potash or aniline red dissolved in the water will serve the same purpose. The use of the housewife's blue bag is also an excellent method.

A useful medium for mixing plaster for impressions in place of water is made by dissolving one part of sodium chloride (common salt) or alum in seven parts of water ; this hastens the setting considerably. Warm water has the same effect.

To retard the setting of plaster, add 2 to 4 per cent of powdered marshmallow root.

Before casting impressions with plaster, be careful to rinse all blood and mucus from the surface ; blood rots the plaster.

Before casting plaster impressions, apply a varnish of shellac ; allow this to dry, and then apply a varnish of gum sandarac evenly until the surface is glazed. The model when cast will have a highly glazed surface.

Shellac Varnish.

Shellac	1 oz.
Alcohol	8 oz.

Mix and dissolve.

Sandarac Varnish.

Gum sandarac	1 oz.
Alcohol	8 oz.

Mix and dissolve.

Just before pouring plaster impressions, always soak them in water for a few minutes (after applying the varnish).

Gloss Varnish for Plaster.

Gum sandarac	12	parts
Gum mastic	6	,,
Gum resin	3	,,
Castor-oil	1	,,
Spirit	30	,,

Soluble aniline dye, sufficient to colour.

Silicate of soda 1 part to water 2 parts, also makes a good model varnish.

If a high glaze is not desired, use a parting medium made by dissolving :—

Powdered soap	1 part
in	
Hot water	8 parts
and adding	
Pure olive oil	6 parts

This separates on standing, so shake well before using. Apply carefully with a camel-hair brush.

Where long teeth are standing alone it is advisable to strengthen them on the plaster model (ordinary household pins of a large size answer this purpose admirably).

In cases where the impression of the tooth touches the metal tray, bend the point of the pin at right angles, heat slightly, and press into the composition on the face of the tooth as near the tip as will secure it a hold.

A slab of slate, marble, or glass on the plaster bench will be found useful when casting models. They leave it with a polished flat under-surface. The glass squares of old photographic plates, with the film removed, make ideal casting slabs, and being about the size of the models they can be moved aside with the models left on, to make room for other work on the bench.

Models cast in Spence or similar hard

plaster must not be so inverted. In these cases, the impressions should be surrounded (boxed-in) by linen strips about 1½ in. wide (previously saturated with wax) to give the desired depth to the model.

If in a hurry, do not omit to retain a few pieces of plaster from the same mix in order to test the stage of the setting. Test the breakage of these until sufficient hardness is reached to enable you to proceed without delay or harm to the cast.

Before softening impression material prior to parting from the model, remove all loose particles of plaster from the tray and composition, cut away any composition overhanging the tray, give the tray a smart tap on the handle with the plaster knife, and it will come away easily from the composition. This also saves much work in cleaning the trays.

Always keep the inside of impression trays polished, smooth, and bright. It facilitates the removal of the compo. A rough surface will not easily part from the composition.

To remove any particles of modelling compo from the trays, boil them in a solution of borax and water.

To re-mould used impression material into suitable discs for future use, solder a brass door-handle on to a tin lid of suitable size ; clean the compo thoroughly, roll into thin sheets on a slab with an ordinary stationery ruler, and cut into discs.

If the plaster models are trimmed to shape when the plaster is half set, it will be accomplished much more easily and in half the time ; only the sharp edges below the composition will then remain to be trimmed after the removal of the composition.

To harden plaster models for vulcanite work, dry the model, and then boil in a pan containing a solution of :—

Borax 1 oz. to water 2 pints.

To harden plaster models for plate work, use :—

Stearin 2 parts to resin 1 part.

Melt in a water bath and dip the previously dried model into the liquid, allowing it to remain for ½ to 1 minute ; remove, drain, and allow to cool.

To disintegrate cast plaster-of-Paris, place in a saturated solution (cold) of hyposulphite of soda (ordinary photographic 'hypo') ; time required, ½ to 1 hour, according to bulk.

To duplicate plaster models, add half a pound of French gelatin to a teacupful of water, heat until the liquid will drop readily from a spoon, cool until the hand can be dipped into it, and then pour round the model and allow to stand overnight. The model should previously be dusted over carefully with French chalk and placed in a mould to confine the gelatin to the shape required. The next day remove the gelatin from the model, coat it with a saturated solution of alum in water, when dry brush over a solution of stearin (2 dwt. in 1 fluid ounce of kerosene). When dry dust lightly with French chalk and pour with plaster-of-Paris. Care must be taken to separate the mould from the plaster as soon as the latter is set. The gelatin compound may be used repeatedly.

To repair a broken plaster model, drill a hole in each fragment so that they come opposite one another when in correct relation. Fill the holes with oxyphosphate of zinc cement, allowing a little surplus. Place the fragments together and allow cement to set.

WAX WORK.

Old wax may be cleansed by melting on water and adding a few drops of sulphuric acid. When cold, remove the block from the surface of the water and clean off the sediment underneath. Melt again, colour with a little alkanet, and strain through cheese-cloth.

To colour—boil the alkanet root in a little wax so as to extract the colour, then add the concentrated deep-coloured wax to the bulk until the desired shade is obtained.

The cuttings of modelling wax can be reworked into sheets by melting in a suitable vessel on the top of water. Take a sheet of glass, a little larger than the size of wax sheet required, and coat with a thin film of glycerin. Plunge it, end on, into the melted wax, and remove quickly with an even movement. If the thickness is not sufficient, dip it quickly again. Cut down the edges on both sides with a sharp knife, and strip off the glass. A large bottle will also answer the purpose, but the wax tends to curl again after flattening out.

An emergency modelling wax can be made from :—

Beeswax 2 parts, paraffin wax 1 part.
Colour with alkanet root.

To strengthen the wax palates (if

used for trying-in plates) keep an assortment of various-sized palates swaged from thin soft metal; choose a suitable size, press it to the approximate shape of the plaster model; cover the model with modelling wax, warm the soft metal palate, and press into wax.

If a hard wax base-plate is preferred alone, make this from impression material rolled into thin sheets.

A good base-plate wax can also be made from :—

Beeswax	9 parts
Gum dammar	1 part.

VULCANITE WORK.

When it is desired to try in a set of incisors or to obtain a rough bite for a complete denture, set up the six upper and lower fronts approximately, and complete the denture with wax blocks, fixing, in the centre of the two lower denture blocks, a molar tooth with well-defined cusps. The wax blocks are softened before putting in the mouth, and the impressions of these molars will give a helpful guide. The incisors can be arranged in the desired positions at the same time.

Another useful method is to keep handy some wire staples with the ends turned at right angles for about $\frac{1}{4}$ in. Whilst the jaws are closed, warm the points and press firmly into the upper and lower wax blocks one on each side of the mouth. This method clamps the two plates together, and they should be removed so fixed.

The most scientific method of obtaining a bite is by the use of the face bow, the technique of which does not come within the limits of this booklet.

If the bite has been correctly taken in the surgery, the front of upper bite block should reach a point about $\frac{1}{8}$ in. below the line of the upper lip. The upper incisors should be set to this line.

When edentulous cases are being set up, mount the six upper incisors first ; then set up roughly the upper bicuspids and molars together directly over the alveolar ridge, and following the occlusal plane.

Start the lower by setting up the second bicuspids and first molars, obtaining the necessary correct articulation with the uppers. Next add the lower first bicuspids, then the second molars, and finally mount the six lower incisors.

Remember the occlusal plane is a vital guide to mounting the bite correctly.

Incisor teeth set up rather irregularly produce a more natural effect than a symmetrical row.

Anatomical pattern teeth should articulate properly without grinding.

When building up after mounting the teeth, do not drop on melted wax ; it saves time to build up with softened cuttings of modelling wax which have been worked into long thin sticks, then harden and carve up to the desired contours.

Swaged tin plates, used in place of wax base-plates for mounting up upper dentures, produce a uniform thickness over the whole of the palate and a stronger denture. Several thin metal plates swaged one over the other give more satisfactory results than one thick one only. A film of sandarac varnish swaged between each plate will successfully bind them together rigidly.

In dentures made on wax base-plates, reproduce the rugæ of the palate by painting on, with a hot spatula or a fine camel's-hair pencil, melted wax, to as near the natural form of the rugæ as possible. It looks nicer, helps mastication and speech, and feels better in the mouth than the smooth surface of the vulcanite.

Remember that impressions taken on the ' closed-mouth ' principle represent the exact facsimile of the marginal contours required in the finished denture.

FLASKING.

Before investing in the flask, clean the mineral teeth and polish the wax surface by rubbing over with a pellet of cotton saturated with chloroform or alcohol.

Never flask wax dentures off the model; always vulcanize on the model. Always flask edentulous cases so that the teeth are embedded in an inverted manner in the deeper part of the flask when opened.

For flasking work, always mix the plaster as stiff as it can be properly worked. A thin mix will not give the required strength, and the mould will be liable to give way under pressure of the rubber.

Always select a flask large enough to allow a sufficient margin of plaster around and below the model to give the required strength of the mould.

Flasks should be kept scrupulously clean. Never purchase flasks that are badly fitted or with incorrectly designed lugs.

A good parting medium for separating the two parts of the flask is made by melting together :—

Modelling wax cuttings	1 part
Olive oil	2 parts

Keep this on the plaster bench and apply with a stiff brush.

Open the flask by warming it in hot water. Never tap the flask or the lugs with a hammer.

Rubber vulcanized on a tin polishing plate is always denser and stronger.

The following is a quick and easy method of swaging a tin plate for polishing the palate of a partial vulcanite plate. After opening the flask see that *the wax palate is hard*; take a piece of S.S.W's or Ney's tin foil No. 30 gauge (specially prepared for rubber work), and burnish it down on to the wax palate with a pad of cotton-wool; trim the edges, and replace the other half of flask in position. Close the flask and press home in the flask press, open again, transfer swaged tin plate to plaster plug, clean and polish well, then proceed as usual. After packing, close the flask with a linen sheet over the rubber, leaving out the tin plate; open, trim off any surplus rubber, and finally close with the tin plate on the rubber. By this method the vulcanite palate is made thinner to the same extent as the thickness of the tin foil, but this being so thin the difference is inappreciable.

After boiling out the wax, make provision for any excess of rubber by cutting a chamber in the plaster *plug* (not the model) all round the mould and about ¼ inch from it, thereby leaving a confining wall next to the mould. *Do not* join this overflow chamber with the mould of the plate by means of channels or gateways. This method will confine the rubber to the mould and only allow the excess to escape over the confining wall in a thin wafer, which can easily be detached from the denture after vulcanization.

Remember that rubber during vulcanization expands on heating and contracts on cooling, particularly when there is much thickness, as in lower dentures.

If gateways are cut in the plaster mould to receive the overflow of any excess, the rubber will be forced along these channels as it expands; and when it contracts on cooling, shrinkage will be greatly increased, owing to part of the bulk of rubber having been forced out and a deficiency created in the mould.

If no overflow chamber is provided, the expansion of the rubber on heating will cause pressure in the flask, resulting in possible distortion of the plaster mould and a raised bite.

The only scientific way to overcome these alternatives is by the use of a flask having correctly designed lugs in combination with a spring-pressure clamp.

The spring clamp will yield to the pressure of the expanding rubber, but as it contracts again the spring will exert sufficient pressure to force the rubber down into the mould again.

To prevent rubber from sticking to the rubber heater, cover the surface of the heater with a sheet of linen (such as new rubber is covered with) damped with hot water.

Always use moist heat when packing rubber.

Before placing in the flask press, place the nearly closed flask in a pan of boiling water and allow it to remain at that temperature for several minutes. This will soften the rubber evenly, and allow the flask to be closed, and any surplus squeezed out, without harm to the investing plaster.

Unvulcanized rubber is exceedingly tenacious. It will resist tremendous

pressure momentarily, but will flow under slight pressure.

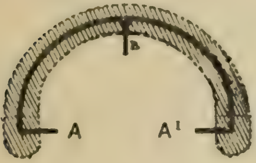
Tremendous pressure can be applied by a flask press, amounting to **tons** of pressure, and if applied suddenly the plaster mould is liable to be injured and a misfit is the result.

Remember to heat the rubber until it is thoroughly softened right through, then close the flask very gradually without haste, allowing the rubber time to flow.

Always allow about 5 per cent excess of rubber when packing.

Rubber properly vulcanized requires no strengthener. If strengtheners are desired, gold alone should be used. Rubber will not adhere to dental alloy or other alloys of silver.

If a gold-wire strengthener is to be fitted in a lower denture turn the two ends inwards so as to project beyond the finished surface of the wax (*see* A, A^1 in diagram), and solder a projection (*see* B in diagram) in the centre to match. The projections become embedded in the plaster when flasking and hold the strengthener in correct position after the wax is boiled out.



The dotted line indicates the surface of the rubber denture.

To avoid dark joints in gum section work, pack pink rubber behind them and let it extend about $\frac{1}{8}$ in. beyond the joint, but do not cover the pins with pink rubber.

VULCANIZING.

Thermometers are liable to defects which may lead to unpleasant results. Steam gauges show variation after repeated use, owing to alteration in the tension of the Bourdon tube. Therefore when vulcanizing always use a thermometer in conjunction with a gas regulating gauge, the thermometer to show the temperature, the gauge to regulate the gas supply. In this way one checks the other.

See that there is always plenty of mercury in the mercury bath of the vulcanizer lid.

Remember that pressure per square inch, inside the vulcanizer, increases far more rapidly than the temperature (*see* Table, page 69).

When the thermometer is used in the mercury bath (of the vulcanizer lid), remember that the mercury will only show the heat of the vulcanizer lid. This may be as much as 18° to 20° lower than the actual temperature of the flasks inside the boiler. Rubber is consequently often vulcanized at a higher temperature than anticipated.

The boiling-point of water is 212° Fahr. (100° centigrade), with a pressure per square inch of 14·7.

To obtain the equivalent of degrees Fahrenheit in centigrade, take the number of degrees Fahr., deduct 32, multiply by 5, and divide by 9.

To obtain the equivalent of degrees centigrade in Fahr., reverse the process; i.e., take number of degrees centigrade, multiply by 9, divide by 5, and add 32.

Unvulcanized rubber should be stored in a warm place.

Rubber subjected to high temperatures for a short time is ruined as regards elasticity and strength. Vulcanization should be carried out by gradually raising the heat, and never exceeding 320° Fahr. (about 300° on the thermometer).

The heat should be gradually raised to about 315° Fahr., taking about 1 hour; then finish the vulcanizing by retaining this temperature for a further 1¼ hours.

The raising of the heat too quickly results in porosity in thick lower dentures. They should be vulcanized at a lower temperature for a longer period.

Remember porosity occurs at the *commencement* of rubber vulcanization.

To avoid porosity *in hurried cases* of this description, cut cores out of old vulcanite plates and embed these in the centre of the thick parts of the denture, or make cores of gum pink rubber.

Black rubber, being purer than brown, requires more careful treatment, with slower heat and longer time.

The shavings of properly vulcanized rubber should curl as they are removed by the scraper.

The directions issued by the different manufacturers of dental rubber vary somewhat. It is advisable, therefore, to follow the makers' instructions to obtain best results.

Allow the vulcanizer to cool down before letting the steam escape. Never open the blow-off tap at once.

Upon removing the flask from the

vulcanizer, if in a hurry, place in cold water until perfectly cold. Never open the flask whilst warm. The best results are obtained by allowing the flask to cool slowly. Irregular cooling is liable to cause the vulcanite to warp.

After vulcanizing, clean out your vulcanizer—also the inside of the lid. A vulcanizer kept clean inside and out and polished on the rim will give less trouble besides adding many years service to its life.

The same water left in the boiler and used repeatedly will hasten corrosion and weaken the metal body.

Never dig the vulcanized denture out of the flask with a knife. Never hit the edge of the flask with a mallet. Insert a knife down between the side of the flask and the plaster, and run it right round the flask so as to cut the whole plaster block out; it can then be broken away carefully from the denture.

Never scrape plaster from the surface of the palate ; use a stiff brush and water only.

If any plaster cannot be removed from the palate surface with a brush, immerse the denture in a weak solution of hydrochloric acid for 15 to 30 minutes, then brush well with soap and water.

A denture correctly waxed up and flasked requires only trimming along the excess line. If the gum margins have been correctly contoured before flasking, never use a file along these edges.

An ordinary steel pen, with three of the four split points broken off, fixed in a pen-holder makes an ideal fine trimming tool for round and between the teeth. An old fine penknife blade ground to a suitable shape is also useful. These must be used with great care, as chipped and broken teeth may result from careless use.

For smoothing up the vulcanite between the teeth, use an orange-wood stick and pumice.

For cutting out file marks, use, in place of sand-paper, a good quality cork on the lathe chuck and a short length cut from a thin piece of cane, pointed and fixed in a chuck.

Instead of pumice and water, try pumice powder and soft soap mixed with water to the consistency of a paste. The soap keeps the pumice on the wheel and denture more effectually. It cuts quicker, and does not give off any dried pumice dust. It is cleaner to use than oil, and may be washed off with cold water.

Polishing by means of cotton duck wheels gives a finer surface than bristle brushes. They should be run at very high speed, and care taken not to warp the plates by the friction heat.

To remove teeth from an old vulcanite denture, bury the case in a tin box filled with casting sand, so as to protect all parts. Cover with a lid and place over a bunsen until the sand is almost red hot. Allow to cool, then pour out the sand, and the teeth can be removed quite clean, whether pin teeth or diatorics.

To clean calcareous deposits from dentures, place in a solution of muriatic acid. The effect is immediate.

A quick repair or to add a tooth when vulcanizing is impracticable. Simply file a dovetail in the vulcanite and fit the tooth. Melt Melotte's metal, pour into the dovetail and around the pins, trim with a hot spatula, and burnish smooth.

Part II.

SAND MOULDING.

A useful tool for breaking up the lumps of casting sand is that used by lead workers—a heavy wooden block about 12 in. long, with a flat base and a handle at one end.

To make sand bind better, moisten it with a mixture of glycerin 1 part, water 2 parts.

For oiled moulding sand, mix with sperm oil.

Always pass your sand through a fine sieve to extract any stray lumps of foreign matter.

In models with front teeth standing, cut away the sand in front of those teeth to a thickness of half an inch. It strengthens the zinc dies and keeps the teeth from ' spreading ' when swaging.

Remember that zinc is destroyed by overheating due to absorption of oxygen from the atmosphere; it becomes sluggish and makes rough casts. To clean zinc, stir a small quantity of sal-ammoniac crystals well into the heated metal and scoop off the dross. This should only be done under an open flue or out of doors, as heavy fumes are given off. The addition of aluminium 1–1000 will render zinc very fluid and improve the casts.

Always line the inside of the zinc ladle with whiting (mixed with water) before melting the metal; this protects the ladle, keeps the zinc clean and also from sticking to the ladle, and, moreover, clearly denotes the use for that particular ladle.

Always keep one ladle for zinc and another for lead, and never use them for any other purpose.

Babbitt metal is harder and tougher than zinc, and does not shrink. This is an alloy of: copper 2, antimony 4, zinc 2, tin 17.

If there are any teeth standing on the zinc die, file these down to about the height that the plate is required to reach.

Zinc teeth can be filed off more easily before the die is cold.

Use a zinc worker's float (or milling file) for filing zinc models; it cuts quicker, the file does not clog up, and can be cleaned better.

Make 3 counter dies, 2 of lead and 1 of tin; use lead for rough swaging, tin for bringing up the sharp lines, and a second lead for fine fitting.

SWAGING.

Remember that plates swaged in a press do not warp so readily in soldering as do struck plates.

When striking up a metal plate with a deep palate, reduce the metal on the edge of the palate to a feather edge;

you can then control better the tendency of the edge to buckle or ‘ fold’. When swaged, this edge can be filed to the full thickness of the plate.

Where front teeth are standing, strips of metal tacked on to the front edge of plate, and then bent over the fronts of the teeth of the die, will guard against the plate slipping in doubtful cases.

In fitting deep palates, it is often an advantage to make a lead counter die to fit the palate only and not extending around the teeth.

During the first rough swaging, layers of tissue paper between the metal and the dies will save the plate from unnecessary rubbing.

Remember always to pickle the plate before annealing, otherwise particles of zinc and lead may be melted into the gold. Nitric acid is most effective.

Pickling solutions :—

Hydrochloric acid, 30 to 35 per cent (acid 2 parts to water 4 or 5 parts), use for dissolving borax and removing flux, etc.

Sulphuric acid, 20 to 25 per cent (acid 2 parts to water 6 to 8 parts), use for all general purposes, removing oxidation, etc.

Nitric acid, 30 to 35 per cent, use for removal of any contaminating base metals during swaging.

Hydrofluoric acid, concentrated (caution : this is dangerous to handle), use only for removing fused investment material after casting.

Remember that nitric acid or boiling HCl will pit the metal by attacking the silver content of the alloy.

After the plate has been roughly fitted, with the mallet, always place the plate in the lead counter and drive the die into same. Do not drive the counter on to the plate and zinc die—it will be very liable to slip.

A rocking plate is usually due to pressure either inside the alveolar ridge or binding around the outer edge of the gum.

Clasps are more quickly shaped and fitted if made from long strips of metal. File to shape, fit, and finally cut off to the desired length. Clasps cut to pattern are not so easily manipulated and shaped.

Upper clasps should be made to fit well down around the necks of the teeth at the back. Lower clasps should be fitted around the bulbous part of the tooth.

Remember that ‘ clasps ’ made from wire are destructive to tooth substance to a greater degree than those cut from plate.

In soldering clasps to the plate, be careful to leave as much of the sides free as possible to give length of spring.

A good emergency sticky wax for

joining clasps to the plate can be made from :—

Resin	2 to 3 parts
Wax	1 part.

Sticky wax should always be removed from the plate with a spatula ; do not use heat or boiling water.

SOLDERING.

Never use pumice powder as an ingredient in investments ; it melts when heated.

The best investment materials are: marble dust, pure sand, silicon, or asbestos.

A good mixture is :—

Plaster-of-Paris	4 parts
and	
(*a*) Pure silver sand .. or (*b*) Coarse silica	5 parts

or an admixture of (*a*) and (*b*) in proportion of 3 to 2.

Keep some thick iron wire bent up to approximately the shape of a flattened ' D ', in assorted sizes. When investing plates for soldering, one of these of a suitable size embedded into the investment round the plate will bind it strongly.

When soldering metal plates, the solder should flow smoothly and easily at the joints; nothing looks worse than solder spreading where not required. Clean unoxidized joints are essential, and flux should be used sparingly.

Where holes are to be filled in, pack same with gold-filling cylinders first. It facilitates the running of the solder.

A lead-pencil mark drawn round the metal will successfully stop the solder from running where it is not wanted.

When binding small articles for soldering, use aluminium wire for the purpose. No solder will take to this metal, so it can easily be removed when the joint is soldered and completed.

Never use lump borax as a flux ; it contains the water of crystallization and swells when heated, causing liability to disturb the position of the joints.

Use calcined borax powder; if not to hand, rub down lump borax with water on a piece of ground glass and paint the joints sparingly.

A match stick cut to a chisel shape makes an ideal applicator for this flux.

A liquid flux may be made by dissolving :—

Borax	12	parts
Boric acid	10	,,
Ammonium chloride	2	,,
Distilled water	100	,,

Always allow the newly invested plate to heat up very slowly until all moisture has been driven off; otherwise steam will be generated and the investment liable to burst, disarranging the parts.

Add solder to the work in very small pieces, well fluxed, previous to heating up.

When commencing to solder, always use a large flame directed around the plate, and, when the case has been heated up to nearly the melting-point of the solder, reduce the flame to a brush point and direct same immediately on to the joint and solder, when the latter will quickly run.

See that the solder is completely fused, otherwise the flux may cause 'pitting.'

For successful soldering, remember to secure :—

1. Clean surfaces in good contact with one another.
2. A free-flowing solder.
3. Proper application and distribution of the heat.

MOUNTING.

When incisor teeth are to be fitted to the gum, festoon the plate under the necks of the teeth to correspond.

In mounting up incisors, fit them to the model first, and get the correct positions for the scallops on the plate edge. Next festoon the metal, and finally let down the necks of the teeth to fit on to the scallops of the plate.

When backing teeth, keep strips of metal ready in two or three suitable widths and about 2 or 3 in. long. These save time and can be handled more easily than small individual pieces of plate.

After backing the teeth with metal, a strong method of securing them is to file a nick on the outer side of the pins, fold them over so that they lie side by side, then file round them so as to form a single small oval head. When soldering the teeth to the plate, allow the solder to run thickly round and over the pins, and a smooth, strong attachment will be formed.

When soldering teeth, great care should be taken to see that no borax gets between the porcelain and the backing.

Remember that an artificial tooth

has very often to stand a strain equal to that of the natural tooth. The force exercised in mastication is estimated at about ~~25 to 30 lb~~.

When fitting pins for tube teeth to the metal plate, file the ends square before wedging into the holes drilled to receive them ; this allows a slight space for the solder to run through freely.

Always place the solder on the lingual side and draw it through with the blow-pipe; then remove the point of the pin which projects through the plate. Pins fitted in this manner will not easily break loose with the strain of mastication.

When vulcanite is to be used for mounting teeth on to metal plates, wire the edge of the plate first.

The marginal contours must first be correctly determined before wiring.

Use *square* wire for this purpose, and after soldering file the outer edges to a round shape ; leave the square inner edge to form a joint with the vulcanite: a very effective finish is produced in this way.

When soldering is required to be done to a metal plate upon which the back teeth are mounted on vulcanite, and it is undesirable to revulcanize, use a low-fusing gold solder made from equal parts by weight of gold and silver. Wrap the vulcanite blocks in folded strips of asbestos (failing this, use tissue paper) and embed in investment material, building same up thickly over the vulcanite. Cut away the investment all round down to the metal plate so as to form an exposed part of metal. This stops a fair amount of heat conductivity. Form a shallow crucible in the mound of investment directly over the vulcanite blocks, and keep these filled with water from a bottle fitted with a dropper top. Direct the flame where soldering is required only. This method has proved very successful in emergencies, but requires quick and careful procedure. The mounds of investment material must essentially be kept well damped.

To solder a gold clasp to a combination plate of metal and vulcanite, suspend the plate in a basin of water, allowing the metal part to project through a sheet of asbestos. This is not a universal application, but will be an exceedingly useful procedure at times.

Part III.

GOLD CASTING.

Gold is forced into the mould either by external atmospheric pressure induced by a vacuum, or by compressed-air, centrifugal or steam pressure.

Remember that the vacuum method extracts the air from the matrix ahead of the incoming gold instead of being forced out by it, and the molten metal runs into the mould from under the blow-pipe flame. In creating a vacuum in the mould, a similar amount of atmospheric pressure is produced upon the molten metal.

The compressed-air, centrifugal, and steam principles force the gold forward against a cushion of air in the matrix, and the blow-pipe must be withdrawn from the metal in order to apply the necessary pressure.

The compressed-air principle gives definite control over the pressure, which can be sustained whilst the gold is solidifying in the mould.

The centrifugal machine causes the gold to be forced into the mould under high pressure which rapidly decreases and is not sustained. Distortion of the mould is frequent. Pressure cannot be predetermined by a gauge.

Steam-generated pressure necessitates a cold wet pad being pressed upon the molten metal. The amount of pressure desired, although adequate, cannot be predetermined by a gauge.

Success in gold casting depends on attention to detail. A perfect impression and model is essential ; cleanliness in materials, workmanship, and appliances is absolutely necessary for good casts.

A thin oil is most suitable for use as a separating medium.

Avoid the use of the fingers or instruments in moulding the wax base-plate to the model. All fine lines will be reproduced in the cast metal.

The best way to adapt the softened sheet wax form to the model is by the use of the tongue.

Be careful not to thin out the wax by stretching, when moulding it over the palate and rugæ.

The single flat sprue generally gives the best results; this is best made from a strip about $\frac{3}{16}$ in. wide cut from a sheet of ordinary modelling wax.

For exceptional cases, such as long lowers, more than one sprue should be used.

The sprues should always be attached to the region of the highest part of the palate.

Wax sprues are best; they burn out without removal, leaving a clean, smooth channel.

Too large a sprue may allow some of the gold to enter the mould before the application of the pressure.

If wire sprues are used, always withdraw them with the invested ring inverted, to prevent any chips from dropping into the sprue channel.

In mixing investment material, do not beat or stir it vigorously, but stir gently and continuously until the water is thoroughly incorporated with every particle of investment, otherwise bubbles will form.

Use water at room temperature for mixing the investment, water direct from the tap is liable to chill the wax, with a consequent shrinkage of the pattern.

The investment is better done if applied in two parts. Before removing the wax from the model, paint a thin mix of investment entirely over it until heavily covered, and allow to set. This will obviate the chance of distorting the wax on removal.

With a second mix fill the investment ring, paint entirely over the palatal side of the wax, and embed it in the ring.

Do not heat up the investment until thoroughly set. Allow it to stand for ½ to 1 hour in a warm place. Never leave the investment to set overnight; it is liable to check. If heated up directly after setting, this will not happen.

Always heat up very slowly until all steam has been driven off.

Do not try to hurry the heating of the investment; nor on the other hand continue it for too long a period. One hour will be found about the average.

Overheating the investment destroys its properties, with consequent liability to distortion of the mould.

When burning out the wax, never allow it to bubble, as it will rot the investment; reduce the heat so that it is not so intense.

In burning out the wax, place the sprue hole downwards so as to allow as much molten wax to drain out as possible; then reverse the ring and heat up until a bright red glow can be seen down the sprue channel.

Never heat up the investment material a second time; the heat once applied must continue gradually and increasingly.

A large thin cast denture can only be made in a *very hot mould*.

When casting aluminium, always allow the investment ring to cool for 5 to 10 minutes after burning out the wax, so as to reduce it to a heat similar to that of the molten alloy.

A shallow and wide-shaped crucible is best for melting the gold; a deep crucible screens the blow-pipe flame from enveloping the metal.

Always allow a fair surplus of metal beyond that necessary for the cast denture.

To approximate the amount of metal (in troy weight) required to reproduce a given wax model (including excess ingot), calculate :—

For gold—the weight of wax model multiplied by 32.
For dental alloy—the weight of wax model multiplied by 26.
For aluminium—the weight of wax model multiplied by 8.

Never use old metal for casting if avoidable; always clean cuttings if new ingots are not available, and melt into an ingot before use. Gold cuttings can be cleansed by sprinkling with a little reducing flux or sal-ammoniac whilst molten. It is preferable to use one of the special casting alloys; sharper and cleaner casts are the result.

Remember that borax used as a flux runs to the bottom of the metal, and is liable to block the sprue hole and channel, and possibly cause faulty casts by entering the mould with the gold.

Always heat the gold to a red heat on an asbestos block before removing the investment ring from the burner. This conserves the heat, in the investment, which would be lost during the time taken to heat the gold in the crucible of the investment.

The pressure required for casting should not exceed 30 lb. for air pressure and 25 to 27 on the gauge for vacuum casting.

Too much pressure obliterates sharp lines and distorts the moulds.

Allow the investment to cool before removing the cast ; do not chill in water.

Always cut out the investment carefully from the ring after casting ; do not knock it out with a mallet.

Fused investment material adhering to the cast can be removed with hydrofluoric acid (*see* PICKLING SOLUTIONS, page 41). Allow it to remain in contact about a quarter of an hour, neutralize the acid in a strong solution of washing soda, and finally rinse in water.

Cut off all cast sprues with a saw; never use cutting nippers with a chance of warping the plate.

RULES SPECIALLY APPLYING TO VACUUM CASTING.

The vacuum method obviates air pockets in the mould; faulty casts are generally caused by insufficient heat, leakage of pressure, imperfect valves, etc., due to neglect, or failure to maintain the appliance in perfect condition.

Remember it is practically impossible to hold a vacuum for any great period.

See that the taps of the vacuum machine are kept clean and air-tight; investment material, if allowed to be sucked in, will soon grind out the fit and cause a leakage of pressure.

Casting rings and bed-plates must be kept clean, well oiled, and free from rust. Neglect of the machine often spells failure. The investment material must be of a porous nature; dense materials produce faulty casts.

Remember that an investment material used for pressure casting is not necessarily suitable or adapted for the vacuum process. But an investment suitable for vacuum casting will also prove satisfactory for all other processes.

See that all surplus investment is removed from the under side of the ring, leaving it slightly concave so as not to touch the bed-plate.

Contact between the ring and bed-plate must be perfect to avoid loss of pressure.

Always use sufficient gold to leave an excess in the crucible to sustain the necessary pressure over the sprue. This produces a denser cast.

The Laing clay crucible device, when fitted over the top of the casting ring so as to seal hermetically the area from the ring to the sprue hole, prevents the passage of air from the atmosphere through the investment. This concentrates the passage of air down the sprue, since the entire remaining portion of the porous investment is made impermeable, and therefore the pressure can be maintained, without loss through penetration, for a much longer period and until the molten metal has congealed.

The author's patent for rings and bed-plate incorporates this device in a new pattern attachment which has also an inner perforated flask or lining (forming an air-space between the inner and outer rings) and a cam-lever clamping device which makes an instantaneous air-tight joint.

This attachment removes, in most

methods of casting, the last obstacle responsible for uncertainty in casting plates. The air has a free and ready passage equally in all directions surrounding the investment, instead of through the bottom only, ensuring the *very rapid* escape of all air in the mould, inducing a quick, sure flow of metal to all parts of the mould, holding it firmly against all cavity walls until it cools, and producing an exact, undistorted casting correct in every line and detail.

Sharp holes in casts indicate heating up too fast, causing flaking of the investment inside the mould.

Round holes, or rounded faulty edges of the metal, point to the investment not being hot enough at the time of casting or too little metal in the ingot.

Dark spots on the cast are caused by gases given off by the combustion of the wax.

Gold insufficiently molten produces casts lacking in marginal sharpness.

Gold overheated results in rough casts.

CAST PORCELAIN WORK.

Castable porcelain opens a new field in both the laboratory and surgery, and is the latest advance in pressure casting.

Remember carbon will contaminate the porcelain, therefore a pattern wax with a low carbon content must be used.

Suitable waxes are Caulk's, Klewe's pink, or Taggart's green.

Use a sprue wire of No. 11 gauge wire.

The crucible former should be cone-shaped, of 45°, so as to afford the greatest surface area exposed to the casting pressure, together with the greatest facility and certainty for the porcelain to flow downward into the sprue gate.

The investment compound must be of the finest and smoothest and specially adapted for this work—do not use ordinary investment compounds.

When mounting the pattern and sprue on the crucible former see that the under side of the pattern is not more than about one-quarter of an inch from the apex of the cone.

Clean over the wax pattern with alcohol, using a soft hair pencil, then coat the crucible former and sprue wire with a very thin coating of oil. After investing, start heating the crucible with a gentle flame after allowing about fifteen to thirty minutes for setting.

Do not leave over an hour before

heating, otherwise the investment will harden, reduce its porosity, and induce distortion.

After removing the sprue wire, place the crucible ring—**sprue end down**—on a wire gauze over a gas ring.

Keep the heat very low and gentle for the first fifteen minutes to allow the wax to melt and drive off the steam slowly from the investment. Then increase the heat to about half capacity for ten minutes, reversing the crucible ring so that the sprue hole is upwards. Then heat with full force of burner for fifteen minutes, cover with a muffle, and allow a final fifteen minutes to volatilize any trace of carbon.

If any traces of carbon deposit are seen around sprue hole, dispel them by the application of a blow-pipe blast.

Remember heating is one of the most important features in porcelain casting and must be properly done.

Before casting, see that the investment is clean and white, and that a red glow is seen when looking through the sprue hole.

The vacuum type of casting machine appears to be the most efficient for casting porcelain, but pressure and centrifugal machines also give good results.

Place the porcelain of the desired shade, with sufficient excess to make a button, in the crucible of investment and allow it to heat up before transferring the crucible ring to the casting machine. Also warm up the plate of the machine with the blow-pipe to prevent the heat being conducted away from the ring and investment when transferred to the machine.

When melting the porcelain do not attempt to make it fluid like gold, fuse only until flat in the crucible and a slight wave motion takes place under the force of the blow-pipe.

The fluidity should be that of treacle, further fusing will destroy the colour.

After casting, allow the cast to cool slowly.

To anneal the porcelain and obtain the greatest edge strength and toughness, plunge the investment ring, while hot, into a bath of boiling mineral cylinder oil. Annealing can also be done by replacing the cooled cast (in the investment and ring) on the gas and reheating up to a cherry red, then allowing it to cool again slowly.

When cool, remove investment and cleanse with soap and water. If any trace of investment compound remains, boil in hydrochloric acid and then wash in water to remove all traces of the acid.

The best way to polish the porcelain is by the use of "Gloss Sticks" or with white oxide of tin mixed to a paste with glycerin, apply with a perfectly new and clean felt or rubber disc or wheel.

The porcelain cast should be uniform and dense, porosity shows faulty technique.

Bubbles in the cast are caused by insufficient heating of investment, cooling of investment after removal from the burner, and delay in casting, or by lack of sufficient excess of porcelain in crucible when fusing.

PART IV.

Useful Data.

The following Table shows the approximate temperature corresponding with the lb. pressure per square inch.

Absolute pressure in lb. per square inch.	Approx. temperature in degrees Fahrenheit.
1	102
5	162
10	193
15	213
20	228
25	240
30	250
35	259
40	267
45	274
50	281
60	292
70	303
80	312
90	320
100	328
110	334
120	341
130	347
140	353

Fusible Alloys for Vulcanizer Safety Plugs, Crown Work, etc.

Melting-point.	Tin.	Lead.	Bismuth.
347°	20	30	5
335°	24	20	5
200°	5	5	10
174°	3	8	8
Melotte's Metal.—			
202°	3	5	8

Low Fusing Metal.—

Bismuth	48 parts
Cadmium	13 ,,
Tin	19 ,,

This melts below the boiling-point of water and can be poured into a wet plaster impression.

When melting fusible metal for use, always remove the ladle from the flame when the alloy is about two-thirds molten. The heat already absorbed will finish the melting without overheating. Overheating diminishes the fluidity of fusible metal, making it sluggish.

Soft Solders.

	Block tin.	Lead.
Plumbing solder	1 part	2 parts
Glazing ,,	1 part	1 part
Fine ,,	2 parts	1 part

Table for Reducing Fine Gold to a Required Carat.

Required carat.	Fine gold.	*Alloy (equal parts of fine copper and silver).
20	20 dwt.	4 dwt.
18	20 dwt.	6 dwt. 16 gr.
16	20 dwt.	10 dwt.
14	20 dwt.	14 dwt. 6 gr.

Plate for Dental Use.

Carat.	Fine gold.	Fine copper.	Fine silver.	Platinum.
22 (for crowns)	22	1	1	—
20 (platinized)	20	2	1	1
18 (for dentures)	18	3 (or 2)	3 (or 4)	—
18 (platinized)	18	2	2	2
16 (for dentures)	16	4	4	—
Dental alloy	—	—	4 to 5	1

Gold Solders for Dental use.

Carat.	Fine gold.	Fine copper.	Fine silver.	Brass or Zinc.
20	40	3	4	1
18	36	4	6	3
16	44	9	12	1
16 (easy flowing)	32	4	10	3
14	48	16	15	—
14 (easy flowing)	28	6	12	3

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* Excess of copper in the alloy gives a warm reddish colour, but the alloy tarnishes more easily. Excess of silver in the alloy gives a whitish colour, imparting hardness and elasticity. Equal parts of copper and silver do not affect the colour.

To ascertain the approximate Carat of Gold.

A.—By Specific Gravity.—

1. Weigh by means of an ordinary fine chemical balance in the usual manner; replace one of the balance pans by a short pan.

2. Suspend the metal by means of a fine thread from this short pan, and immerse in a beaker of distilled water. See that any air-bubbles on the surface of the metal are removed, and weigh again, ascertaining loss of weight.

3. Divide result of No. 1 by result of No. 2 to obtain the sp. gr. (The weight in air divided by loss of weight in water equals sp. gr.).

4. Compare with following Table.

Sp. gr.		ct.
19·4	=	24
18·68	=	22
17·87	=	20
17·05	=	18
16·18	=	16
14·45	=	12

B.—By Acid.—

Test the metal (freshly scraped) with a drop of strong nitric acid.

Gold 24 ct. to 18 ct. No action
,, 16 ct. will turn a brownish colour
,, 14 ct. ,, ,, a deeper brown

and the lower the carat the deeper the colour.

The acid test also distinguishes the the following metals by turning

Silver, a greyish colour.
German Silver, a greyish green.
Victoria Metal and Brass, a pale green.
Nickel, black.

Gold-plating without a Battery.

Gold chloride	15 min.
Potassium cyanide	6 drachms 15 min.
Potassium hydrate	2 drachms 30 min.
Sodium phosphate	4 drachms
Distilled water	2 pints.

Boil the solution in a porcelain dish, and suspend in it the article (thoroughly cleaned and absolutely free from grease) by means of a thick aluminium wire, and keep it on the move for 1 or 2 minutes. Wash, dry, and polish.

Nickel-plating Steel without a Battery.

Zinc chloride	2 oz.
Distilled water	1 pint.

Solution of nickel sulphate q.s. to give a green colour.

Boil the solution in a porcelain dish and suspend in it the article (thoroughly cleaned and absolutely free from grease), keep boiling for ½ to 1 hour. Wash, dry, and polish.

Gold-plating Aluminium without a Battery.

No. 1.—	Potassium hydrate	2 oz.
	Distilled water	1 pint
No. 2.—	Mercuric chloride	5 oz.
	Distilled water	1 pint
No. 3.—	Gold chloride	4 drachms
	Distilled water	5 oz.

Immerse in solution No. 1 for a few minutes, remove and wash in distilled water; then immerse in dilute hydrochloric acid until bubbles commence to form, then immerse in solution No. 2 for a few moments; remove and immerse in dilute hydrochloric acid again, then transfer at once to solution No. 3.

Remember that aluminium is attacked by salts under certain conditions (e.g., in the presence of an organic acid).

To Frost Aluminium.

Heat caustic soda slightly in a porcelain dish; saturate a cotton pellet with this solution and wipe over the plate. Follow this with a cotton pellet dipped in warm nitric acid. Finally wash in water.

Fuses for Electrical Apparatus & Mains.

Fusing current.	Tin fuse wire in S.W.G.	Lead fuse wire in S.W.G.	Copper wire in S.W.G.
1 ampère ..	36	35	47
5 ,, ..	25	23	38
10 ,, ..	21	20	33
15 ,, ..	19	18	30
20 ,, ..	17	17	28
25 ,, ..	16	15	26

Comparison of Dental Wire Gauges.

British Dental Size.	DIAMETER.		Approx. Imperial Standard Wire Gauge.	Approx. American Wire Gauge.
	Inches.	Millimetres.		
Round—				
Extra thin	·021	·559	24	24
A	·036	·914	20	19
B	·041	1·0	19	18
1	·048	1·2	18	17
2	·052	1·3	17·5	15·5
3	·056	1·4	17	15
4	·071	1·8	15	13
5	·078	2·0	14	12
Half Round—				
6	·066 × ·032	1·6 × ·813	16 × 21	14 × 20
7	·076 × ·036	1·8 × ·914	15 × 20	13 × 19
8	·083 × ·042	2·0 × 1·0	14 × 19	12 × 18

British Dental Size.	DIAMETER.		Approx. Imperial Standard Wire Gauge.	Approx. American Wire Gauge.
	Inches.	Millimetres.		
Oval—				
1	·102 × ·054	2·6 × 1·4	12 × 17	10 × 16
2	·1145 × ·0615	3·0 × 1·6	11 × 16	9 × 14
3	·130 × ·071	3·3 × 1·8	10 × 15	8 × 13
4	·143 × ·0755	3·7 × 1·9	9 × 14·5	7 × 13·5
5	·165 × ·084	4·1 × 2·0	8 × 14	6 × 12
6	·183 × ·091	4·6 × 2·3	7 × 13	5 × 11
7	·204 × ·107	5·0 × 2·6	6 × 12	4 × 10
8	·221 × ·114	5·6 × 3·0	5 × 11	3 × 9
Square—				
1	·048	1·2	18	17
2	·056	1·4	17	15
3	·064	1·6	16	14
4	·072	1·8	15	13
5	·080	2·0	14	12
6	·092	2·3	13	11
7	·104	2·6	12	10

Comparison of Dental Plate Gauges.

British Dental gauge.	Inch.	Mm.	S.W.G.	American gauge.
4	·010	·254	31	30
5	·0136	·345	29	28
6	·016	·416	27	26
7	·019	·508	25	24
8	·022	·559	24	23
9	·024	·610	23	22

Comparison of Porcelain Tooth Shades.

Approximate Shades comparing with Ash's New Standard Guide.*

Ash's				
New Standard No.	Old Shade letter Shade No.	S. S. W.'s.	De Trey's.	D. M. Co.'s.
1	B1	35	5	1
2	B21	35	6	21
3	B2	36	8	21
4	B3L	38	9	4
5	B3	41	20	4
6	B4	42	21	23
7	B5	43	25	—
8	Bx1	26	1	9
9	Bx2	27	2	10
10	Bx3	39	7	4
11	NB1	34	4	27
12	NB2	36	8	28
13	NB3	45	32	—
14	C2	27	3	8
15	C3	31	13	—
16	D1	27	28	9
17	D2	30	9	25
18	D3	32	14	—
19	D4	48	24	—
20	E2	40	15	11
21	E3	32	14	13
22	E4	48	23	—
23	E5	49	24	—
24	F1	—	9	—
25	F2	40	15	22
26	F3	42	20	—
27	H2	30	13	10
28	H3	31	15	11
29	H4	32	21	—

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* As the porcelain and general characteristics of each make of tooth vary so considerably, the above chart is approximate only, and gives the nearest equivalents.

Table of Approximate Melting-points and Sp. Gr. of Metals.

		Symbol.	Fahr.	Cent.	Sp. gr.
Aluminium	..	Al	1157	625	2·6
Bismuth	..	Bi	514	268	9·5
Brass ..	..	—	1869	1020	8·5
Cadmium	..	Cd	609	320	8·6
Copper	..	Cu	1929	1054	8·9
Gold (fine)	..	Au	1942	1061	19·3
Iridium	..	Ir	3092	1700	22·4
Lead ..	..	Pb	617	325	11·4
Mercury	..	Hg	−40	−40	13·6
Nickel	..	Ni	2912	1600	8·8
Palladium	..	Pd	2732	1500	11·5
Platinum	..	Pt	3227	1775	21·5
Silver ..	..	Ag	1904	1040	10·5
Tin ..	..	Sn	450	232	7·2
Zinc ..	..	Zn	779	415	7·0

PART V.

CHEMICALS USEFUL IN THE LABORATORY.

Acids.—Hydrochloric Acid.—Muriatic Acid (HCl); "Spirits of Salts." A colourless or yellowish fuming liquid, highly corrosive. It should be stored in a glass-stoppered bottle, and in a cool place. (*See* Pickling Solutions, page 40.)

—— **Hydrofluoric Acid.** — Fluoric Acid. A colourless liquid, very corrosive, used commercially to etch glass and therefore must only be kept in a rubber or guttapercha bottle. The fumes given off are pungent and irritating. It must be handled with great care, as it is very dangerous if accidentally spilt on the skin unless washed off **at once** and instantly neutralized by applying a swab saturated with 5 per cent solution of ammonia. Used for etching porcelain inlays and removing fused casting investment. (*See* page 41.)

Acids. — **Nitric Acid** — Aqua Fortis $(HNO)_3$. A colourless and fuming liquid, highly corrosive and caustic. It should be stored in a glass-stoppered bottle in a cool dark place. It is explosive with alcohol or glycerin. (*See* Pickling Solutions, page 41.)

—— **Nitro-hydrochloric Acid.**—Aqua Regia. This is a mixture of the two acids and is formed by mixing 3 parts (by volume) of nitric acid with 10 to 14 parts of hydrochloric acid. It should be prepared freshly as required, owing to decomposition.

—— **Oxalic Acid.**—$(H_2C_2O_4+H_2O)$. Odourless and transparent crystals readily soluble in water. In solution it is extremely useful as a bleaching agent; it enters into the composition of many metal polishes.

Acids.—Sulphuric Acid.—Oil of Vitriol (H_2SO_4). A colourless, oily or heavy liquid, highly corrosive and caustic. It darkens in colour by contamination. When diluting, remember that the acid should be added slowly to the water to avoid heat being generated. Water added to the acid will cause dangerous spluttering and evolution of heat.

Alcohol.—Ethyl Alcohol (C_2H_5OH).

—— **Absolute Alcohol.**—Ethyl Hydroxide, containing not more than 1 per cent by weight of water (sp. gr. 0·795 to 0·800).

—— **Rectified Spirit.**—S.V.R. Contains 90 per cent by volume (85·68 per cent by weight) of ethyl hydroxide (sp. gr. 0·834).

—— **Methylated Spirit (Industrial).**—Rectified spirit, containing 5 per cent of wood naphtha (by volume). This may only be obtained for manufacturing purposes by permission of the Excise Authorities and used in the manufacture of specified articles according to regulations.

—— **Methylated Spirit (Mineralized or Denaturalized).**—A mixture of rectified spirit with 10 per cent of wood naphtha and $\frac{3}{8}$ per cent of mineral naphtha, of a sp. gr. of 0·8, both by volume (sp. gr. 0·828).

Alum.—Ammonium or Potassium Sulphate of Aluminium. It occurs in colourless and odourless octahedral crystals, having a sweetish and strongly astringent taste. Soluble in water, insoluble in alcohol.

Ammonia.—(NH_3). Occurs as a colourless gas, soluble in water. **Solution of Ammonia** contains about 35 per cent by weight of ammonia gas, is very volatile and has a very penetrating odour, strongly alkaline in reaction, and is strongly irritating to the mucous membrane. Incompatible with all acids and alkaloids. Should be kept in glass-stoppered bottles in a cool place.

Ammonium Chloride.—Sal Ammoniac; (NHCl). Occurs as white crystals or crystalline powder, odourless. Soluble 1 in 3 of water. Incompatible with alkalis and mineral acids.

Boracic Acid. — Boric Acid. — (H_3BO_3). Occurs in transparent crystals, soluble in water or alcohol. Incompatible (in aqueous solution) with carbonates.

Borax. — Sodii Biboras; Sodium Borate; ($Na_2B_4O_7 . 10H_2O$). Occurs in colourless crystals or white powder. Soluble in water and glycerin, insoluble in alcohol. Incompatible with acids or glycerin. Combined with Formalin, it is useful for sterilizing instruments (1 drachm to 1 pint). Forms the base of most hard-soldering fluxes.

Calcium Carbonate. — Precipitated Chalk ($CaCO_3$). A fine white odourless powder, precipitated from an aqueous solution of calcium chloride and sodium carbonate. Insoluble in alcohol and practically so in water.

—— **Creta Præp.**—Prepared Chalk, Whiting ($CaCo_3$) ; is native calcium carbonate, freed from impurities ; a fine white powder.

Chloroform. — ($CHCl_3$). A heavy clear liquid having a pungent odour and sweet taste. It is soluble in alcohol, ether, and volatile oils, also in 200 parts of water. It is non-inflammable, but its vapour will burn. It should not be used near a flame. It should be stored in a dark, cool place, in glass-stoppered amber bottles. Commercially it is used as a solvent for gums and other insoluble substances.

Cochineal.—The dried insect "*coccus cacti*". Used as a colouring agent when powdered and dissolved in the form of the liquid—"Liquor Cocci".

Cochineal.—Carmine. The active red colouring principle prepared from the cochineal insect. Insoluble in water. Its use is preferable to cochineal for colouring dentifrices, etc.

—— **Solution of Carmine** for use as a colouring agent. Carmine 1 part, solution of ammonia (·880) 1 part, water 10 parts.

Collodion.—A 4 per cent solution of gun-cotton (pyroxylin) in a mixture of ether (3) and alcohol (1). It is a colourless syrupy liquid, and highly inflammable. Applied to the skin it forms "new-skin" as a protective for small cuts and abrasions.

Copper Sulphate.—Cupri Sulphas, Blue Vitriol ($CuSO_4+5H_2O$). Deep-blue transparent crystals, prepared by the action of sulphuric acid on copper. Freely soluble in water, but almost insoluble in alcohol.

Cream of Tartar.—Potassium Bitar trate ($KNC_4H_4O_6$). Occurs in colourless and odourless crystals or white powder. It is soluble in water, but only slightly so in alcohol.

Cresol.—(Trikresol). Obtained from coal-tar, as a straw-coloured liquid, darkening with age and exposure to light. It should be kept in glass-stoppered amber bottles in a dark place. A 50 per cent strength in a linseed-oil soap solution is similar to the well-known commercial disinfectant Lysol.

Formalin.—A colourless liquid containing 40 per cent solution of formaldehyde with a characteristic pungent and irritating odour. Mixes readily with water, alcohol, and glycerin. A powerful disinfectant and bactericide.

Kaolin.—China clay—Fuller's-earth. A native aluminium silicate, occurring in a soft white powder. Insoluble in water. (*See* Talc.)

Linseed Oil.—Oleum Lini. A pale yellow oil expressed from flax seed. Should always be kept handy in case of burns or scalds. The best means of application is a mixture of equal parts of linseed-oil and lime-water (Carron oil).

Lycopodium is a very fine yellow powder obtained from a species of mosses. It is so fine that it will float on water. It is very absorbent ; and is used for dusting plaster models before sand moulding (for zinc dies, etc.) to prevent adhesion of the damp sand.

Magnesium Silicate.—(*See* Talc.)

Potassium Hydroxide.—Caustic Potash (KOH). Occurs in white deliquescent fused masses, odourless but highly caustic ; very soluble in water and alcohol.

Pumice Stone.—Lapis Pumicis. A native volcanic rock, and when ground, a heavy grey powder. Obtainable in a large range of grits; the most suitable for laboratory use being: coarse 60 mesh, medium 90 mesh, fine 120 mesh.

Putty Powder.—Stanni oxidum (Oxide of Tin). A heavy native greyish-white powder, insoluble in water. Used as a polishing medium for hard metals, ground porcelain surfaces, etc.

Paraffin: Petrolatum.—These are various mixtures of hydrocarbons obtained by the distillation of petroleum, and may be divided into three groups according to consistency—hard, soft and fluid.

—— **Paraffin Dur.**—(Hard)—Paraffin Wax. A colourless crystalline solid, inodorous, tasteless, and semi-transparent. Insoluble in water, slightly so in alcohol, more so in ether, and readily (by heat) in oils and fats. Sp. gr. 0·82 to 0·94. Can be obtained with melting-points varying from 100° to 145° F.

Paraffin.—Paraffin Molle.—(Soft)—Vaseline. A white or yellow semi-solid mass according to refinement. It contains some of the softer members of the paraffin series of hydrocarbons. Odourless and tasteless. Solubilities similar to Paraffin Dur.

—— **Paraffin Liquid.**—Oleum Petrolei.—Vaseline Oil or liquid. A colourless, clear, oily fluid mixture of the paraffin series of hydrocarbons. Colourless and tasteless and without fluorescence. Sp. gr. varies from 0·885 to 0·875.

—— **Petroleum.**—Kerosene—Mineral Naphtha. The lubricating and lighting oils also obtained from the same series.

—— **Ceresin.**—Is a hard white or yellow wax with a melting-point about 130°F. Prepared from earth wax deposits.

Resin.—Colophony. Occurs in transparent amber-coloured lumps, and is the distillation residue from the various natural exudations of the species of

Pinus. Freely soluble in alcohol, ether, and chloroform, insoluble in water.

Rouge.—Ferric Oxide (Fe_2O_3). A heavy deep-red powder prepared from sulphate of iron. Chiefly used alone or as an ingredient of polishing powders for metals.

Sapo.—Soap. Prepared by boiling any fat with a caustic alkali (sodium or potassium hydroxide). The sodium soaps are hard, the potassium soaps are soft.

—— **Castile Soap.**—(Sapo Durus). Is a white solid, free from any rancid smell, easily dried and powdered. Prepared from olive oil. Used in the preparation of dentifrices.

—— **Soft Soap.**—(Sapo Mollis). Is an unctuous semi-solid, and generally prepared from olive- or linseed-oils, the former being a yellowish-white, the latter brownish-green in colour. Commercial products are prepared from crude oils or fats.

Sapo.—Curd Soap.—(Sapo Animalis). Is a hard whitish soap made from purified animal fat.

Silex.—Silica (SiO_2). A colourless crystalline quartz, insoluble in water. It is obtainable ground to varying degrees of fineness.

Sodium Bicarbonate.—($NaHCO_3$). Is a white powder or small opaque crystals with an alkaline taste. Insoluble in alcohol, but freely in water. Incompatible with acids and metallic salts. Added to the water in which instruments are sterilized, it prevents rusting.

Sodium Carbonate.—Commercial washing soda. Colourless and translucent crystals having a caustic taste, strongly alkaline.

Sodium Hydroxide.—Caustic Soda ($NaOH$). Occurs in hard white deliquescent masses; it is odourless but very caustic. Freely soluble in water and alcohol.

Sodium Hyposulphite.—Colourless, transparent prisms, with a bitter taste. Freely soluble in water. A solution is useful for removing stains and dullness from nickel-plated instruments.

Sodium Silicate (Solution of).—Liquid Silex; Waterglass.—A clear or yellowish viscid liquid, having an alkaline taste, miscible in all proportions of water.

Sulphur.—(S). Prepared by purification from the crude native sulphur and moulded into thick sticks. It has a characteristic odour and yellow colour. Used chiefly for cementing tube-teeth to metal dentures.

—— **Flowers of Sulphur.**—A sublimed fine yellow powder with characteristic odour and colour. Insoluble in water, but partly so in alcohol, chloroform, and ether.

—— **Precipitated Sulphur.** A fine whitish powder, odourless and tasteless, prepared by precipitation from calcium sulphide solutions.

Talc. — Magnesium Silicate — Soapstone. It occurs as native magnesium silicate in a soft greyish-white powder, greasy and unctuous to the touch. **French Chalk** (creta gallica) is similar. **Kieselguhr** and **Dimatos** are diatomaceous earths, very soft and light, with similar properties.

Zinc Chloride.—($ZnCl_2$). A white granular powder or in fused mass or sticks. Odourless, very deliquescent and extremely caustic. Freely soluble in water or alcohol.

Zinc Oxide.—(ZnO). A fine white powder, odourless and tasteless. Insoluble in water or alcohol. Zinc ointment is astringent and protective, being universally used for burns, sores, and inflammatory conditions of the skin.

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John Wright & Sons Ltd., Printers, Bristol.

2nd Edition. *Foolscap 8vo.* 3/- *net.*
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